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**Description**FIELD OF THE INVENTION

**[0001]** This invention relates to prostheses which are implanted in bone and, in particular, to an improved system for preparing a cavity for receiving the prosthesis and to improved prosthesis configurations for use with such cavities.

BACKGROUND OF THE INVENTION

**[0002]** A variety of prosthesis configurations have been proposed and used to implant prostheses in bone. See, for example, Noiles, U.S. Patent No. 4,219,893 (see Figures 7-9); Meyer, U.S. Patent No. 4,549,319; Noiles, U.S. Patent No. 4,790,852; Penenberg et al., U. S. Patent No. 4,808,185; Noiles, U.S. Patent No. 4,846,839; Luman, U.S. Patent No. 5,002,578; and the C-2 Conical Collar™ Hip System of the Kirschner Medical Corporation, Timonium, Maryland, 21093.

**[0003]** In overview, one or more cavities are prepared at the end of the bone for receiving the prosthesis. The prosthesis is then inserted into the prepared cavity and held in place by a mechanical fit or in some cases by bone cement. The initial fit between the prosthesis and the bone is critical to the long term success of the prosthesis especially with a mechanical fit.

**[0004]** Two fundamental criteria which a prosthesis and its cavity should meet are: (1) proper transfer of force from the prosthesis to the bone (see Meyer, U.S. Patent No. 4,549,319); and (2) ready formation of the cavity so as to achieve an accurate fit with the prosthesis (see Noiles, U.S. Patent No. 4,790,852).

**[0005]** With regard to the first criterium, force needs to be effectively transferred from the prosthesis to the cortical (hard/strong) bone and, in particular, to the cortical bone at the extreme end of the bone, e.g., the proximal end of the femur in the case of the femoral component of a hip joint, the distal end of the femur in the case of the femoral component of a knee joint, and the proximal end of the tibia in the case of the tibial component of a knee joint.

**[0006]** In the case of knee joints, instead of directly transferring force to the cortical bone, it is also common practice to have the prosthesis abut primarily cancellous bone and have the cancellous bone transmit force to the cortical bone. In such cases, the cancellous bone must have sufficient structural strength to sustain the loads imposed on it.

**[0007]** The application of forces of physiological magnitudes to bone fosters bone growth in the region where the forces are applied. The transfer of force to the cortical bone at the extreme end of the bone thus leads to bone growth in this critical region. If the end of the bone is not loaded, bone resorption can occur in this region. This leads to a diminished amount of bone which is undesirable in its own right and is particularly troublesome

should the prosthesis fail and need to be replaced.

**[0008]** With regard to the second criterium, for repeatable success, the cavity for the prosthesis must be created in a precise and reproducible manner. The cavity

5 preparation procedure preferably accommodates the anatomical variation between patients. Moreover, the surgical site does not favor complex procedures for preparing a cavity for implantation of a prosthesis in bone.

**[0009]** Prior techniques have achieved these two criteria to greater or lesser extents. Loading at the extreme 10 end of the bone has not been a natural consequence of the prosthesis' configuration in many cases. With regard to bone preparation, many prostheses require cavities whose configurations do not lend themselves to precise

15 machining. The loading and bone preparation criteria have often led to compromises regarding other desirable criteria. For example, the ability to provide a one piece prosthesis which can be used in either the right or left hand bones of the patient has been difficult with prior 20 prostheses.

**[0010]** In WO94/12124 there is made known a prosthesis according to the preamble of claim 1 appended hereto.

25 SUMMARY OF THE INVENTION

**[0011]** In view of the foregoing state of the art, it is an object of the invention to provide a prosthesis and cavity configuration which maximize the loading of the patient's hard bone at the extreme end of the bone in which the prosthesis is implanted.

**[0012]** It is an additional object of the invention to provide a cavity whose geometry can be readily machined in the patient's bone with a high degree of precision and 35 which at the same time is a relatively close match to the shape of the patient's hard bone at the end of the bone, as for instance, a close match to the shape of the wall of the femur anterior to the calcar for a femoral hip prosthesis.

**[0013]** It is a further object of the invention to provide a one piece neutral (symmetric) prosthesis which can be used with both right and left bones. It is an additional object of the invention to achieve this goal with the removal of a minimum of hard bone.

**[0014]** It is a still further object of the invention to provide a prosthesis which can be implanted in either an anteverted, neutral, or retroverted orientation. In connection with this object, it is a further object to minimize the removal of bone for each of these orientations.

**[0015]** To achieve these and other objects, the invention provides a prosthesis for implantation in bone according to claim 1.

**[0016]** The invention also provides a system according to claim 9.

**[0017]** Preferred features of the invention are set out in claims 2 to 8.

**[0018]** As discussed in detail below, prostheses having the inventive configuration readily achieve the twin

goals of high force transfer to the end of the bone and precise fit to a prepared cavity within the bone.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0019] Figure 1 is a perspective view of a hip femoral prosthesis constructed in accordance with the invention.

[0020] Figure 2 is a side view of the prosthesis of Figure 1. This view corresponds to an anterior view when the prosthesis is implanted in the left femur of a patient.

[0021] Figure 3 is a medial view of the prosthesis of Figure 1.

[0022] Figure 4 is a superior view of the prosthesis of Figure 2.

[0023] Figure 5 is an inferior view of the prosthesis of Figure 2, partially in section along lines 5-5 in Figure 2. This figure illustrates that the sum of the radii  $R_1$  and  $R_2$  of the bone-engaging surfaces of bodies 18 and 20 is greater than the distance D between axes 22 and 24 for at least one transverse cross-section through the prosthesis.

[0024] Figures 6 and 7 are superior views of the prosthesis of Figure 1 implanted in a typical orientation in the left (Figure 6) and the right (Figure 7) femur of a patient. The views shown in these figures are referenced to the posterior aspect of the femoral condyles 10 of the knee.

[0025] Figures 8 and 9 are superior views of a patient's left femur which have been prepared to receive the prosthesis of Figure 1. Figure 8 corresponds to the normal preparation of the bone so as to provide approximately 15° of anteversion of the neck of the femoral prosthesis relative to the femoral condyles 10. Figure 9 corresponds to a preparation of the bone which provides approximately 7° of retroversion of the neck of the femoral prosthesis relative to the femoral condyles 10.

[0026] Figure 10 shows an alternate construction of the prosthesis of the invention in which one of the cone-like, bone-engaging bodies of the prosthesis has a concave profile.

[0027] Figure 11 shows a construction of the prosthesis of the invention suitable for use as the tibial component of a knee joint.

[0028] Figure 12 shows an instrument for use in creating a cavity in a patient's bone for receiving the prosthesis of Figure 1.

[0029] Figures 13 and 14 are superior views of a patient's left femur. These figures compare the configurations of prepared cavities for receiving a prior art prosthesis (Figure 13) and the prosthesis of Figure 1 (Figure 14).

[0030] Figures 15 and 16 are perspective views of the cavities of Figures 13 and 14, respectively.

[0031] Figure 17 is a superior view of a patient's left femur prepared for orienting a prior art prosthesis so that it has a greater degree of anteversion than would be provided by the normal orientation of the prosthesis with respect to the anatomy of the patient's bone.

[0032] Figure 18 is an anterior view of the femur of Figure 17 along lines 18-18 in Figure 17.

[0033] Figure 19 is a superior view of a patient's left femur prepared for orienting the prosthesis of Figure 1 so that it has a greater degree of anteversion than would be provided by the normal orientation of the prosthesis with respect to the anatomy of the patient's bone.

[0034] Figure 20 is an anterior view of the femur of Figure 19 along the same direction as lines 18-18 in Figure 17.

[0035] The foregoing drawings, which are incorporated in and constitute part of the specification, illustrate the preferred embodiments of the invention, and together with the description, serve to explain the principles of the invention. It is to be understood, of course, that both the drawings and the description are explanatory only and are not restrictive of the invention.

[0036] The reference numbers used in the drawings correspond to the following:

20	10	femoral condyles of the knee
	13	femoral hip prosthesis
	14	neck
	16	stem
25	18	first cone-shaped (cone-like) region of proximal bone-engaging surface
	20	second cone-shaped (cone-like) region of proximal bone-engaging surface
	22	axis of first cone 18
30	24	axis of second cone 20
	26	line of intersection between cone 18 and cone 20
	28	femoral bone
	30	longitudinal axis of femoral bone
35	32	instrument for cutting cavity 200
	34	body of instrument 32
	36	bearing member of instrument 32
	38	shaft of instrument 32
	40	conical cutter of instrument 32
	42	stop collar of instrument 32
40	44	calcar region of femur bone 28
	46	line tangent to condyles 10
	48	line through center of calcar region 44
	50	line parallel to line 46
	52	bone removal region of posterior wall of femur
45	54	bone removal region of anterior wall of femur
	56	bone removal region of anterior wall of femur
	58	concave profile of cone-like body
	60	cone-like body of tibial prosthesis
	62	cone-like body of tibial prosthesis
50	64	cone-like body of tibial prosthesis
	180	conical cavity for cone 18
	200	conical cavity for cone 20

#### DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0037] Although the invention can be practiced with a variety of prostheses, a preferred application is to fem-

oral hip prostheses. Accordingly, the initial description of the invention will be in terms of such a prosthesis, it being understood that this description is not intended to limit the scope of the invention.

**[0038]** Figures 1-5 show the structure of a femoral hip prosthesis 13 constructed in accordance with the invention. The prosthesis includes a neck 14 for receiving the ball (not shown) of the prosthesis and an elongated stem 16 which extends into the shaft of the patient's femur when the prosthesis is implanted. Neck 14's orientation with respect to prosthesis 13 is preferably neutral with regard to anteversion/retroversion. That is, the prosthesis is preferably symmetric with regard to a longitudinal plane through the neck. As discussed below, this allows the prosthesis to be used with various anteversion/retroversion angles as well as with right and left femurs, thus reducing inventory requirements, i.e., there is less need to separately manufacture, ship, and store left, right, and special circumstance prostheses.

**[0039]** The bone-engaging surface of prosthesis 13 includes a first cone-shaped (cone-like) portion 18 and a second cone-shaped (cone-like) portion 20. For ease of reference, these portions will be referred to herein as first cone 18 and second cone 20.

**[0040]** As shown in Figure 2, first cone 18 has an axis 22, which corresponds in this case to the longitudinal axis of the prosthesis as defined by stem 16, and second cone 20 has an axis 24 which is parallel to, but not collinear with, axis 22. When this prosthesis is implanted, axis 22 is essentially aligned with longitudinal axis 30 of femoral bone 28 (see Figure 17).

**[0041]** As shown in Figure 3, cone 18 has an apical cone angle  $\alpha$  and cone 20 has an apical cone angle  $\beta$ . The cone angles and spacings of axes 22 and 24 in Figures 1-5 are such that cones 18 and 20 intersect along line 26.

**[0042]** A variety of cone angles and axis spacings can be used in the practice of the invention. In the case of a hip femoral prosthesis, cone angle  $\alpha$  is preferably about 6°, cone angle  $\beta$  is preferably in the range between about 60° and about 120°, and the spacing between axes 22 and 24 is preferably chosen so that the apex of cone 20 lies in the vicinity of the surface of cone 18.

**[0043]** As discussed fully below, one of the advantages of the invention is that it allows flexibility in the angular orientation of prosthesis 13 about the longitudinal axis of the patient's bone. Cone angle  $\beta$  is selected with this orientation feature in mind.

**[0044]** Specifically, larger cone angles produce a shallower cone 20 which allows more flexibility in angular orientation without sacrificing the integrity of the patient's bone. Smaller cone angles, on the other hand, provide more purchase into the end of the patient's bone, which may be required for some applications. Such smaller cone angles give less flexibility with regard to angular orientation.

**[0045]** The particular cone angles for any specific application can be determined by persons skilled in the art

from the disclosure herein and the specific requirements of a particular application of the invention. In Figures 1-5, cone 20 is shown as having a representative cone angle of 90° which provides a substantial level of angular orientation flexibility in comparison to prior art prostheses (see discussion of Figures 13-20 below).

**[0046]** Implantation of prosthesis 13 in a patient's bone requires the preparation of two adjacent conical cavities 180 and 200 (see Figures 8 and 16) to receive cones 18 and 20, respectively. Cavity 180 is aligned with the longitudinal axis 30 of femoral bone 28 and is prepared using a conventional conical reamer (see, for example, Figures 4-5 of U.S. Patent No. 4,790,852). The longitudinal location of cavity 180 along axis 30 is chosen with the ultimate location of prosthesis 13, including cones 18 and 20, along that axis in mind. Thus, the conical reamer used to prepare cavity 180 preferably includes means for indicating the depth of the reamer relative to the end of the patient's bone.

**[0047]** Although the foregoing discussion has been in terms of geometrical cones, it should be understood that cone-like bodies 18 and 20 are not limited to such shapes. Rather, each of these bodies needs to be generally cone-shaped and to have a form such that a cavity

to receive the body can be generated by a cutting tool rotating about a fixed axis.

**[0048]** The cone-like shape is important because it allows the prosthesis to reach out toward the hard bone in the region of the end of the patient's bone. That is, it gives the prosthesis a longitudinal cross-section at the end of the bone which is similar to the longitudinal profile of the hard bone at that end. Aspherical shape of the type used in U.S. Patent No. 4,808,185, does not have this property.

**[0049]** The ability to be received in a cavity formed by a cutting tool rotating about a fixed axis is important because it means an excellent fit can be achieved between the prosthesis and the cavity under the real world conditions which exist in the operating room.

**[0050]** Figure 10 illustrates a body 20 having such a cone-like shape. Body 20 of this figure has a concave longitudinal profile 58, which can even more closely correspond to the inside surface of the hard bone in some cases than a true geometrical cone. This would not be

**[0051]** true for a convex longitudinal profile. Accordingly, the prostheses of the invention have cone-like shaped bodies or regions whose longitudinal profiles are either straight or concave.

**[0052]** For the more general case of cone-like bodies, as opposed to bodies which are true cones, the relative shapes of the bodies can be described in terms of their overall longitudinal profiles, rather than their cone angles. In general terms, cone-like body 20's surface area and diameter decreases faster than those of cone-like body 18 in moving away from the end of the bone in which they are implanted.

**[0053]** In most cases, the transverse cross-section of the prosthesis and the cavity in the region of the end of

the bone will include two intersecting circular parts with displaced centers.

**[0053]** Cavity 200 is preferably prepared using instrument 32 shown in Figure 12. The instrument has a body 34 whose outer surface includes a conically shaped portion which seats in conical cavity 180.

**[0054]** Body 34 carries bearing member 36. Shaft 38, which carries cutter 40 at its distal end, is rotatable and slideable within bearing member 36. Shaft 38 is rotated and advanced into the patient's bone by conventional means, such as, a T-handle (not shown). Stop collar 42 is mounted on shaft 38 and defines the end point of the advance of cutter 40 so that the spatial relationship of cavities 180 and 200 matches that of cones 18 and 20.

**[0055]** The instrument of Figure 12 can be used to prepare a cavity in the patient's bone for various orientations of the neck 14 of the prosthesis relative to the remaining calcar region 44 of the patient's femur. Figures 8-9, 14, 16, and 19-20 illustrate some of the possibilities.

**[0056]** In each of these figures, the remaining calcar region 44 is shown having a degree of anteversion of about 7° relative to line 46 which is tangent to condyles 10. That is, line 48 which passes through the center of calcar region 44 and intersects longitudinal axis 30 is rotated 7° counterclockwise relative to line 50 which is parallel to line 46 and also intersects longitudinal axis 30. (This geometric construction is for purposes of illustration only since, as is well known in the art, there is a considerable variation in version angles and anatomy in human hips.) For ease of reference, a prosthesis whose neck 14 is aligned with line 48 will be referred to as having an anteversion of 7°.

**[0057]** The average anteversion of the natural femoral head of the femur is greater than 7° because the natural neck turns in a forward direction as it rises from the calcar region. For many patients, the anteversion of the natural femoral head is in the range of about 12° to about 15°. Accordingly, in practice, it is generally desired to orient the neck 14 of prosthesis 13 at some greater amount of anteversion than that of the remaining calcar region 44, e.g., between about 12° and about 15° counterclockwise from line 50 for a left femur.

**[0058]** This generally preferred orientation of the neck 14 of prosthesis 13 is illustrated in Figures 6-8. Specifically, Figure 6 shows implantation of prosthesis 13 in the patient's left femur at 15° anteversion and Figure 7 shows implantation in the right femur, again at 15° anteversion. Figure 8 is the bone preparation for the implantation of Figure 6. The bone preparation for the implantation of Figure 7 is the mirror image of that of Figure 8.

**[0059]** A cavity for use in providing a relatively extreme orientation of neck 14 of prosthesis 13 is shown in Figure 9. In this case, the neck of the prosthesis when implanted is retroverted by 7° with respect to line 50. Although such an orientation is generally unlikely, it may be needed for some patients. It should be noted that

some removal of the posterior wall of the femur is likely to occur during preparation of the bone for this orientation of the prosthesis (see region 52 in Figure 9). However, due to the shallowness of cone-like cavity 200, the remaining bone still provides a strong structural support for the prosthesis.

**[0060]** A cavity for use in providing another relatively extreme orientation of neck 14 of prosthesis 13 is shown in Figure 19. In this case, the neck of the prosthesis when implanted is anteverted by more than 15° with respect to line 50. Again, some removal of the wall of the femur is likely to occur during preparation of the bone for this orientation of the prosthesis, specifically, removal of a small portion of the anterior wall is likely to occur (see region 54 in Figures 19 and 20). Again, however, the remaining bone still provides a strong structural support for the prosthesis because the flare of the bone in region 54 is in the same direction as the flare of the cone 20. This is particularly so because the force from the prosthesis to the bone in the calcar region is directed posteriorly where the external wall of the femur is still intact. It should be noted that the orientation of Figure 19 will be more common than the orientation of Figure 9.

**[0061]** Significantly, a single neutral prosthesis can be used for all of the orientations shown in Figures 6-9 and 19, as well as for a variety of orientations within and beyond those illustrated. As discussed above, prosthesis 13 is preferably symmetric with respect to neck 14, i.e., the prosthesis has neutral version. Through the use of a cone 20 which is relatively shallow, such a neutral version prosthesis can be used for both the right and left femurs as illustrated in Figures 6 and 7, and for the relatively extreme orientations of the prosthesis as illustrated by Figures 9 and 19. Specifically, the shallow cone 20 allows for angular variation about axis 30 of the placement of the prosthesis in the calcar region of the bone without compromising the bone's structural strength or the fixation of the prosthesis.

**[0062]** This "shallowness" aspect of the invention is illustrated in Figures 13-16 which show a prepared femur for receiving the prosthesis of the invention (Figures 14 and 16) and a prepared femur for receiving a prior art prosthesis (Figures 13 and 15). As illustrated in these figures, the bone-engaging surface of the prosthesis of the invention in the calcar region tends to be as much "on the bone" as "in the bone" because of the shallowness of cone 20. This geometry further encourages the favorable loading of the bone at the end of the bone.

**[0063]** For the prior art prosthesis, on the other hand, the bone-engaging surface of the prosthesis in the calcar region is clearly "in the bone". As a result, rotation of this part of the prior art prosthesis to provide additional anteversion causes the removal of an unacceptable amount of the anterior wall of the femur as shown in Figure 18 (see 56 in Figure 18).

**[0064]** Put another way, if the geometry of the prior art prosthesis were to be used in a one piece neutral prosthesis and that prosthesis were to be oriented in a more

anteverted orientation than that of the calcar region, more critically placed bone would have to be removed than for the comparable prosthesis constructed in accordance with the geometry of the present invention.

**[0065]** The ability to use a single neutral prosthesis for a variety of orientations is a significant advantage of the invention because it reduces the costs of manufacture, shipping, and storage relative to the use of right-handed and left-handed prostheses. Moreover, the prosthesis of the invention provides greater latitude of orientation compared to single orientation left and right hand prostheses.

**[0066]** Further, the invention provides this multiple orientation advantage in a single piece prosthesis, as opposed to a modular prosthesis (see U.S. Patent No. 4,790,852). It should be noted that the two cone geometry of the invention can be used with modular prostheses, if desired.

**[0067]** Although it is not preferred, the present invention can be used in connection with left and right handed prostheses with anteverted necks if desired.

**[0068]** Figure 11 shows application of the invention to a tibial knee prosthesis. In this case, the prosthesis includes three cone-like bodies 60, 62, and 64. As shown in this figure, bodies 62 and 64 have the same shape. Different shapes can be used for these bodies if desired.

**[0069]** In addition to hip joints and tibial components of knee joints, the invention can also be used for various other joints, such as, the humeral component of a shoulder joint prosthesis, the femoral component of a knee prosthesis, and the like.

**[0070]** The prosthesis can be constructed of various biocompatible materials suitable for implantation now known or subsequently developed. For example, it can be made of a cobalt-chromium-molybdenum alloy (see ASTM-F75 and ASTM-F799) or a titanium alloy such as Ti-6Al-4V (ASTM-F136). The cone-like, bone-engaging bodies of the prosthesis can include surface texturing, such as the steps shown in the figures. These surfaces can also be porous coated, plasma sprayed, chemically modified, or the like to enhance fixation. Similarly, the surfaces can be coated with bone growth stimulating materials such as hydroxylapatite.

**[0071]** Although preferred and other embodiments of the invention have been described herein, additional embodiments may be perceived by those skilled in the art without departing from the scope of the invention as defined by the following claims.

## Claims

1. A prosthesis for implantation in bone comprising an outer surface at least a portion of which is adapted to engage bone, said portion comprising a first region (18) which is a cone-like surface of revolution about a first axis (22) and a second region (20) which intersects the first region, the first and second

regions being adapted to be implanted in an end of a bone, characterized in that the second region is a cone-like surface of revolution about a second axis (24) which is parallel to, and non-collinear with, the first axis.

2. A prosthesis according to Claim 1 having at least one transverse cross section where the first and second regions have radii ( $R_1, R_2$ ) and the sum of the radii is greater than the distance (D) between the first and second axes.
3. A prosthesis according to Claim 1 or 2 having a first end and a second end, said first end being adapted to support a joint motion surface, wherein said cone-like first and second regions expand in a direction from the second end towards the first end.
4. A prosthesis according to Claim 1, 2 or 3 wherein the bone has a longitudinal axis and the first axis is adapted to be substantially aligned with said longitudinal axis.
5. A prosthesis according to Claim 1 or 2 further comprising means (14) for supporting a joint motion surface.
6. A prosthesis according to Claim 1 or 2 further comprising a joint motion surface.
7. A prosthesis according to any one of the preceding Claims comprising a stem (16) which has a longitudinal axis and which comprises the first cone-like region whose axis is substantially collinear with the longitudinal axis, the second cone-like region protruding from the first cone-like region.
8. A prosthesis according to any one of the preceding Claims wherein one of the cone-like surfaces (18) of revolution is longitudinally longer than the other surface (20).
9. A system comprising the prosthesis of any one of the preceding Claims and an apparatus for implanting said prosthesis, said apparatus comprising means (32) for cutting a second cone-like cavity (200) in a patient's bone (28) displaced from a first cone-like cavity (180) in the bone which defines a first axis, said means comprising:
  - (a) guide means (34) for engaging the surface of the first cone-like cavity;
  - (b) cutting means (40) for cutting the second cone-like cavity; and
  - (c) means (36,38) for guiding the cutting means along a second axis displaced from the first axis, the second axis being parallel to, but not collinear with, the first axis;

wherein said first and second cone-like cavities are surfaces of revolution adapted to respectively receive the cone-like surfaces of revolution of the prosthesis.

### Patentansprüche

1. Prothese zur Implantation in einen Knochen, welche eine äußere Oberfläche umfaßt, von der wenigstens ein Abschnitt dafür eingerichtet ist, mit dem Knochen in Kontakt zu kommen, wobei der Abschnitt einen ersten Bereich (18), welcher eine konusartige Rotationsfläche um eine erste Achse (22) ist, und einen zweiten Bereich (20), welcher den ersten Bereich schneidet, umfaßt, wobei der erste und der zweite Bereich dafür eingerichtet sind, in einem Ende eines Knochens implantiert zu werden, **dadurch gekennzeichnet, daß** der zweite Bereich eine konusartige Rotationsfläche um eine zweite Achse (24) ist, die parallel und nicht kollinear zu der ersten Achse liegt.
2. Prothese nach Anspruch 1 mit wenigstens einem transversalen Querschnitt, an dem der erste und der zweite Bereich Radien ( $R_1, R_2$ ) besitzen und die Summe der Radien größer als der Abstand (D) zwischen der ersten und der zweiten Achse ist.
3. Prothese nach Anspruch 1 oder 2 mit einem ersten Ende und einem zweiten Ende, wobei das erste Ende dafür eingerichtet ist, eine Gelenkbewegungsfläche zu tragen, wobei der konusartige erste und zweite Bereich sich in einer Richtung von dem zweiten Ende zum ersten Ende erstrecken.
4. Prothese nach Anspruch 1, 2 oder 3, bei der der Knochen eine Längsachse besitzt und die erste Achse so eingerichtet ist, daß sie im wesentlichen entlang der Längsachse ausgerichtet ist.
5. Prothese nach Anspruch 1 oder 2, welche weiterhin eine Einrichtung (14) zum Tragen einer Gelenkbewegungsfläche umfaßt.
6. Prothese nach Anspruch 1 oder 2, welche weiterhin eine Gelenkbewegungsfläche umfaßt.
7. Prothese nach einem der vorherigen Ansprüche, welche einen Schaft (16) umfaßt, welcher eine Längsachse besitzt und welcher den ersten konusartigen Bereich umfaßt, dessen Achse im wesentlichen kollinear zu der Längsachse liegt, wobei der zweite konusartige Bereich aus dem ersten konusartigen Bereich hervorragt.
8. Prothese nach einem der vorhergehenden Ansprüche, bei der eine der konusartigen Rotationsflächen

(18) in Längsrichtung länger als die andere Fläche (20) ist.

9. System, welches die Prothese nach einem der vorhergehenden Ansprüche und eine Vorrichtung zum Implantieren der Prothese umfaßt, wobei die Vorrichtung eine Einrichtung (32) umfaßt, um eine zweite konusartige Vertiefung (200) in einen Knochen (28) eines Patienten zu schneiden, die zu einer ersten konusartigen Vertiefung (180) in dem Knochen versetzt ist, welche eine erste Achse festlegt, wobei die Einrichtung folgendes umfaßt:
  - (a) eine Führungseinrichtung (34) zum Anlegen an die Fläche der ersten konusartigen Vertiefung,
  - (b) eine Schneideeinrichtung (40) zum Schneiden der zweiten konusartigen Vertiefung, und
  - (c) Einrichtung (36, 38) zum Führen der Schneideeinrichtung entlang einer zweiten Achse, die von der ersten Achse beabstandet ist, wobei die zweite Achse parallel, jedoch nicht kollinear zu der ersten Achse liegt,

wobei die erste und die zweite konusartige Vertiefung Rotationsflächen sind, die dafür angepaßt sind, jeweils die konusartigen Rotationsflächen der Prothese aufzunehmen.

### Revendications

1. Une prothèse pour une implantation dans un os, comprenant une surface extérieure dont au moins une portion est adaptée pour s'articuler avec l'os, ladite portion comprenant une première région (18) qui est une surface conique de révolution autour d'un premier axe (22), et une deuxième région (20) qui coupe la première région, les première et deuxième régions étant adaptées pour une implantation dans une extrémité d'os, **caractérisée en ce que** la deuxième région est une surface conique de révolution autour d'un deuxième axe (24) qui est parallèle à, et non-colinéaire avec le premier axe.
2. Une prothèse selon la revendication 1, ayant au moins une section transversale où les première et deuxième régions ont des rayons ( $R_1, R_2$ ), et la somme des rayons est plus grande que la distance (D) entre les premier et deuxième axes.
3. Une prothèse selon la revendication 1 ou 2 ayant une première et une deuxième extrémité, ladite première extrémité étant adaptée pour soutenir une surface de mouvement articulaire, dans laquelle lesdites première et deuxième régions coniques s'étendent dans une direction allant de la deuxième extrémité vers la première extrémité.

4. Une prothèse selon la revendication 1, 2 ou 3, dans laquelle l'os a un axe longitudinal et le premier axe est adapté pour être aligné de façon substantielle avec ledit axe longitudinal.
- 5
5. Une prothèse selon la revendication 1 ou 2 comprenant en outre des moyens (14) pour soutenir une surface de mouvement articulaire.
6. Une prothèse selon la revendication 1 ou 2 comprenant en outre une surface de mouvement articulaire.
7. Une prothèse selon l'une quelconque des revendications précédentes, comprenant une tige (16) ayant à un axe longitudinal et comprenant la première région conique dont l'axe est substantiellement colinéaire avec l'axe longitudinal, la deuxième région conique dépassant de la première région conique.
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8. Une prothèse selon l'une quelconque des revendications précédentes, dans laquelle l'une des surfaces coniques (18) de révolution possède une longueur longitudinale plus grande que l'autre surface (20).
9. Un système comprenant la prothèse selon l'une quelconque des revendications et un dispositif pour implanter lesdites prostheses, ledit dispositif comprenant des moyens (32) permettant de couper une deuxième cavité conique (200) dans l'os d'un patient (28) placé à l'écart de la première cavité conique (180) dans l'os qui définit un premier axe, ledit moyen comprenant :
- 25  
30  
35
- (a) Des moyens de guidage (34) pour positionner la surface de la première cavité conique ;  
 (b) Des moyens de découpe (40) pour découper la deuxième cavité conique ; et
- 40
- (c) des moyens (36, 38) pour guider les moyens de découpe le long d'un deuxième axe placé à l'écart du premier axe, le deuxième axe étant parallèle à, mais non colinéaire avec, le premier axe ;
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- dans lequel lesdites première et deuxième cavités coniques sont des surfaces de révolution adaptées pour recevoir respectivement les surfaces de révolution analogue à un cône des prostheses.
- 50

FIG. 1.

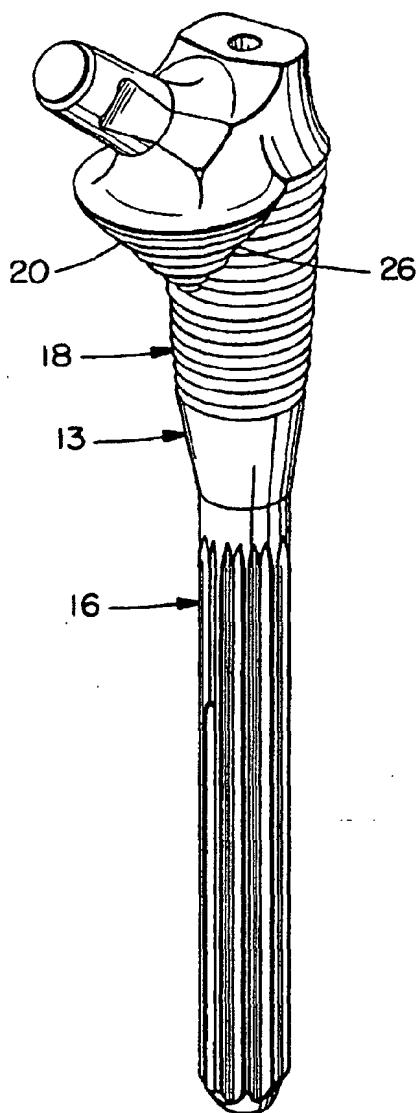


FIG. 2.

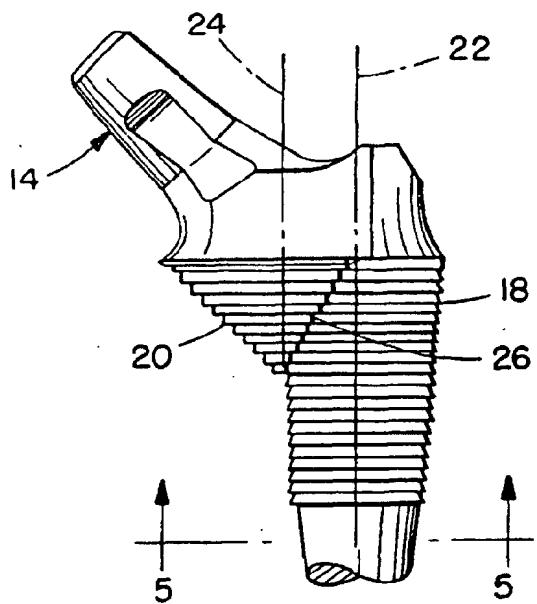


FIG. 3.

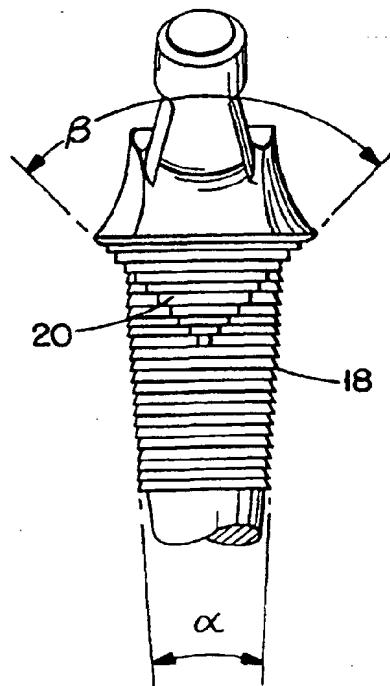


FIG. 4.

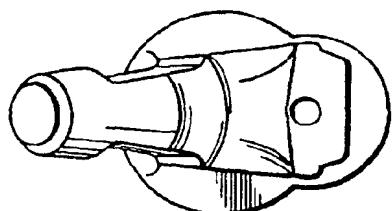


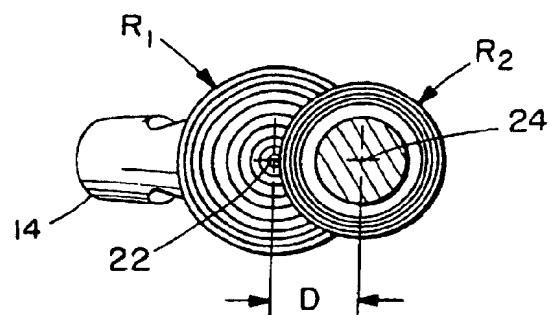
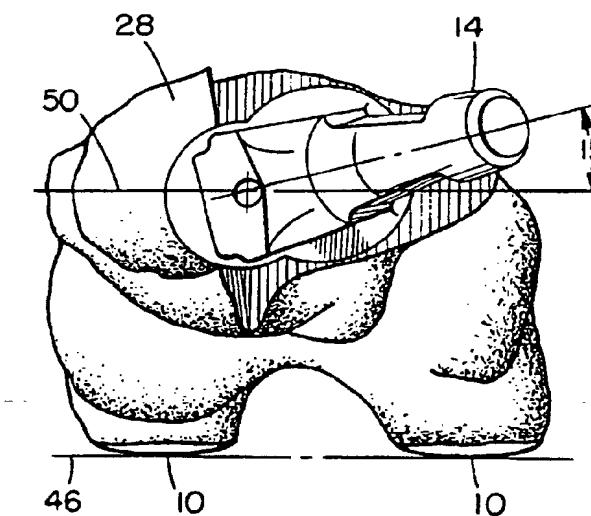
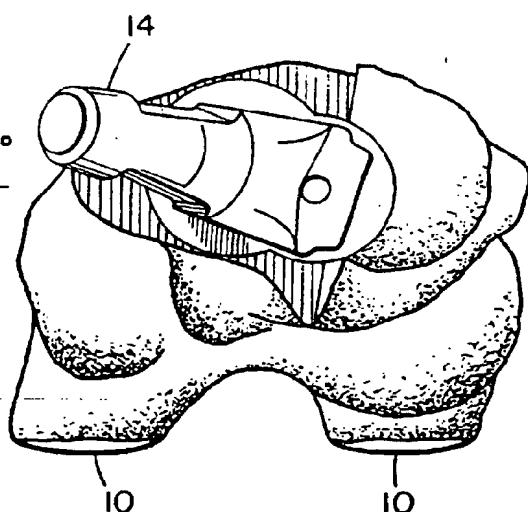
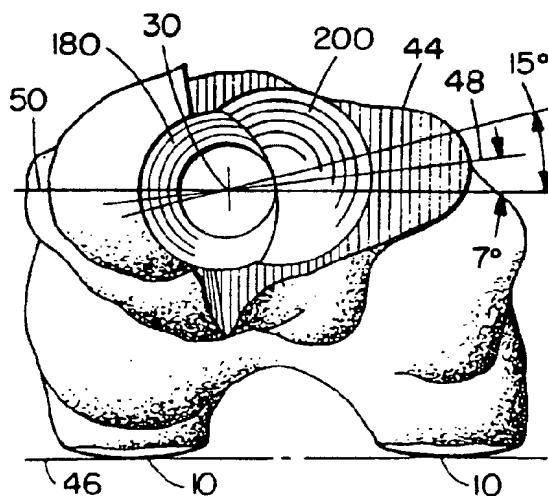
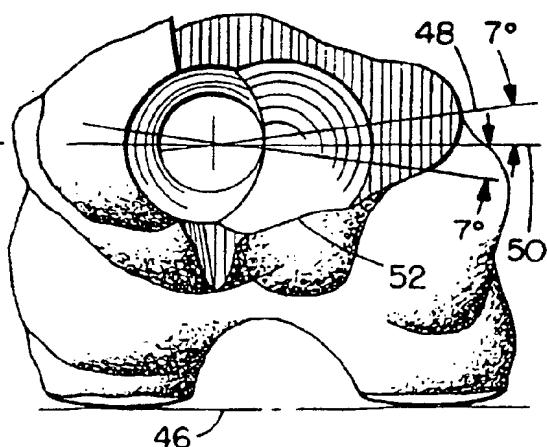
FIG. 5.FIG. 6.FIG. 7.FIG. 8.FIG. 9.

FIG. 10.

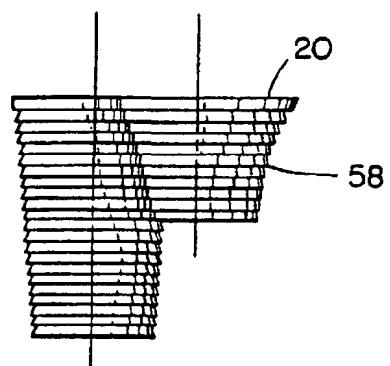


FIG. 11.

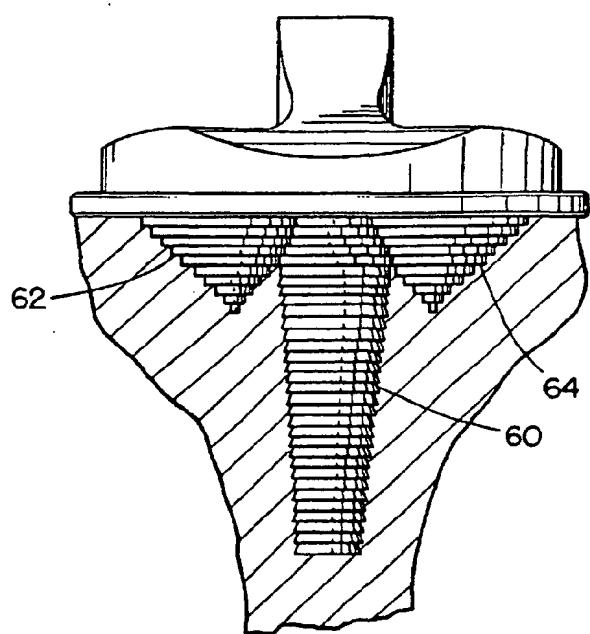


FIG. 12.

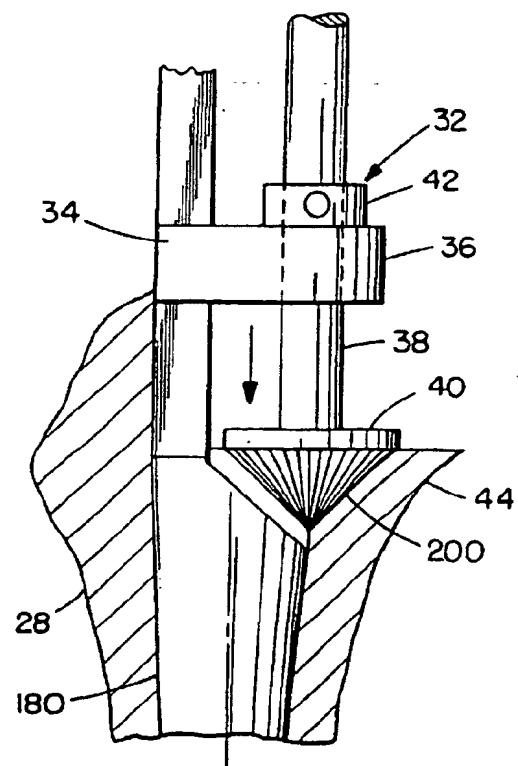


FIG. 13.

PRIOR ART

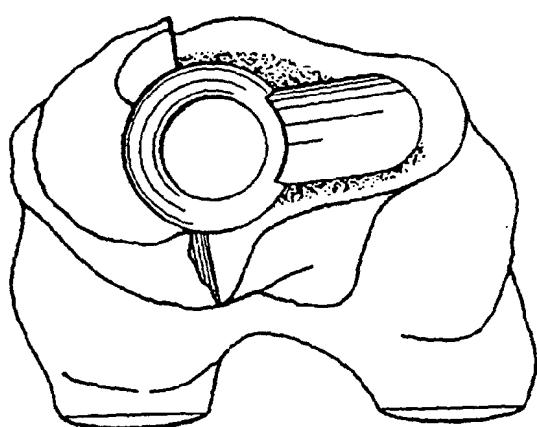


FIG. 14.

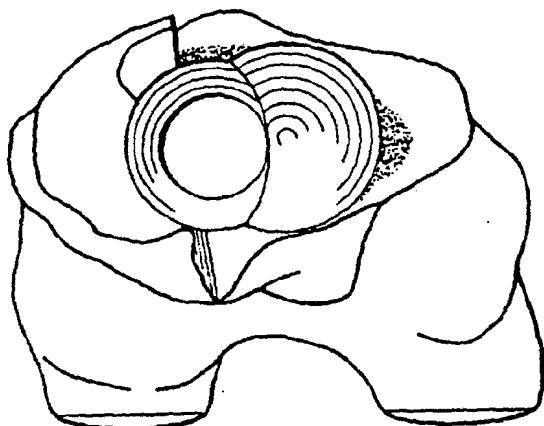


FIG. 15.

PRIOR ART

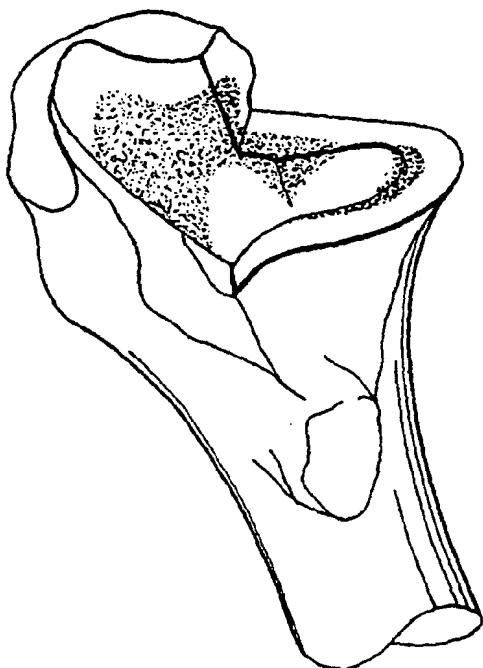


FIG. 16.

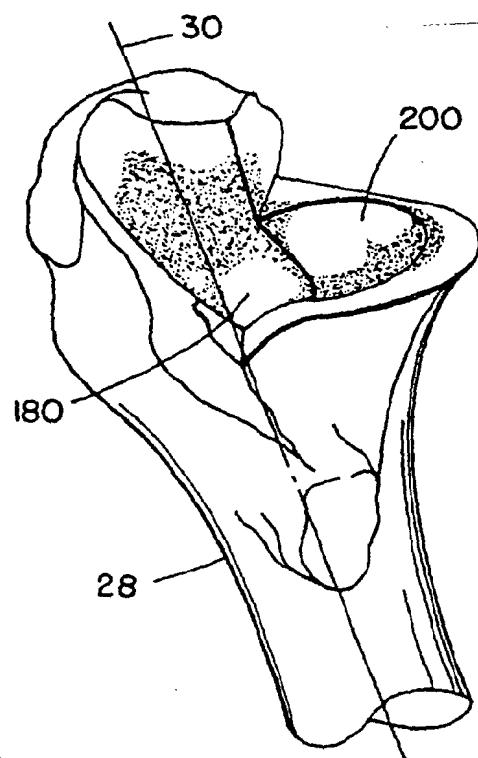


FIG. 17.

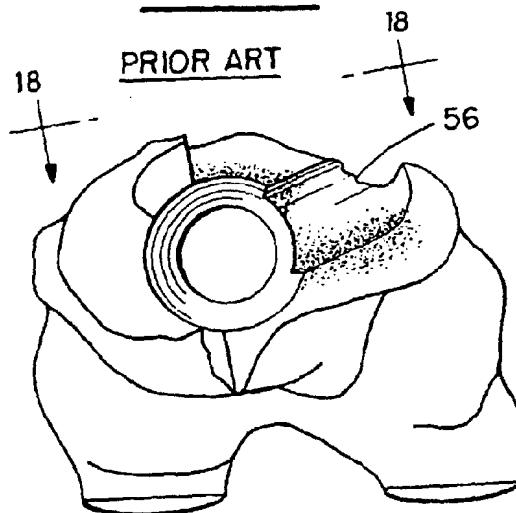


FIG. 18.

PRIOR ART

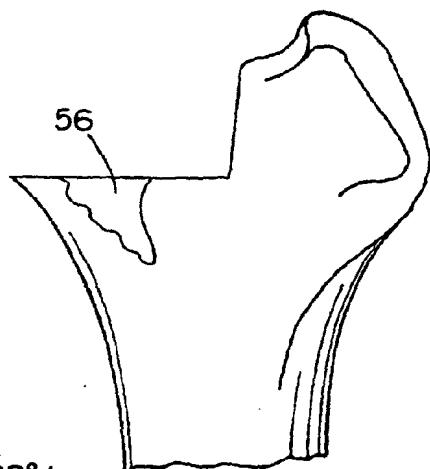


FIG. 19.

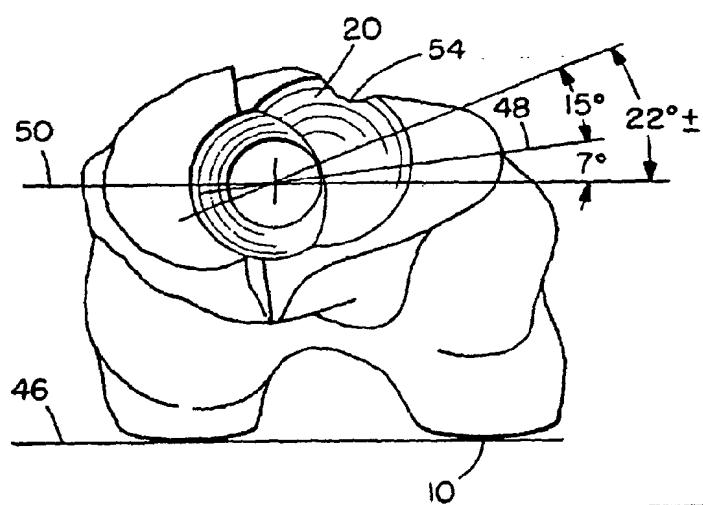


FIG. 20.

